Ministry of Environment and Energy

FOR YOUR information

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How Acid Rain Affects Forests, Crops and Wildlife

INTRODUCTION

Symptoms of forest decline have been observed in areas of North America for many years. The visible signs include dieback of twigs and branches in the tree crown, the production of smaller leaves and premature autumn coloration in foliage. The current decline of maple and hardwood in Canada appears to be more severe and more extensive than those of the past. Studies conducted in Ontario and Quebec indicate that acid deposition — and other air pollutants transported over long distances — may be contributing to forest decline.

THE ROLE OF THE FOREST

Forests play a vital role in the life of our plant. Through photosynthesis, carbon dioxide and water react with sunlight to form organic matter and generate oxygen. This process allows plants to store energy derived from the sum and provide the basic carbon materials which become plant tissues.

Plants produce foliage, woody tissues, roots, flowers, fruit and seeds. Eventually, all these fall to the soil. Dead leaves , tree litter, fallen wood and dead roots provide the sources of energy and nutrients for fungi, bacteria, insects, earthworms and other animals. The living forest provide shelter, nesting sites and food for many animal species and helps to store water.

In addition, forests support the economy through the lumber industry , hunting fishing and recreational activities.

THE EFFECTS OF ACID RAIN

Sulphur dioxide (SO_2), is a major source of acidity in rain. In sufficient concentrations, sulphur dioxide can be toxic to foliage. In the presence of water, sulphur dioxide is converted to sulphuric acid. In the form of acid rain, sulphuric acid is deposited on soil and affects soil chemistry.

The other major acidic component of acid rain is nitric acid which is derived from nitrogen oxides (NO_x). Contrary to the effects of sulphur dioxide, nitrogen compounds may stimulate plant growth. This stimulation may be beneficial on a short term basis but in the long term, the effects are harmful and nitrogen may be released to the aquatic system.

The majority of terrestrial scientists would agree that the impact of acid rain does not directly destroy the above ground parts of the plants. What acid rain does is disrupt the natural soil processes. This includes leaching of soil nutrients and a reduction in nutrient status (calcium, magnesium and potassium), which leads to decreases in soil pH. Under conditions of low soil pH (less than 5.2), there is an increased availability of aluminum. Aluminum. in turn, can be toxic to plant roots and soil organisms.

This is a slow process.

At first, soils are able to counter inputs of acidic materials. Eventually, however, the basic soil chemicals will be used up and the entire buffering capability of the soil will be lost. The soil acidity will increase very rapidly and adversely affect the terrestrial ecosystem. Due to differing soil composition in different regions, this will not occur geographically in a uniform manner. In addition, the time scale for this phenomenon could vary widely from afewyears to a few centuries.

SUMMARY OF CLASSIFICATION OF TERRESTRIAL (SOIL) SENSITIVITY TO ACID DEPOSITION IN ONTARIO

The capacity of soils to tolerate acidic inputs has been classified based on soil chemistry, texture and depth. The relative areas falling into each sensitivity class are shown in the table below.

Class	Total area (km^2)	%ofProvince
Highly Sensitive	335,000	31.3
Moderately Sensitive	192,000	18.0
Non-sensitive	247,000	23.1
Organic (not rated)	295,000	27.6

FOREST AREAS AT RISK

The forest most likely to be affected are those on soils which are shallow, sandy and/or have limited pools of buffering chemicals. Such conditions are prevalent in the Precambrian Shield area of Canada.

The areas most likely to affected include the Muskoka and Parry Sound districts of Ontario where acid rain may enhance the decline of sugar maple trees. Areas further in Ontario or in Quebec have similar soil conditions, but because they are further from the sources of pollution, the amounts of acid deposited are lower and the acidification process proceeds more slowly.

Much of the recent severe dieback of sugar maples in Ontario was associated with the defoliation by the Forest Tent Caterpillar, especially in the Muskoka/Haliburton areas. Experiments have shown that growth of the insect was greater on foliage subjected to acidic conditions and the caterpillars matured earlier. In recent years, the Gypsy Moth has been spreading northward in Ontario and could create an additional problem for the forests.

Severe dieback of white birch trees in the shoreline area of Lake Superior, especially in the Wawa area and at other sites in Ontario have been under investigation. Potential causes of the dieback may have involved acidic precipitation or acidic marine fog. Soils in this area are coarsely textures and extremely acidic. Natural succession of plant communities changes induced by climatic shift cannot be discounted.

ECONOMIC CONSEQUENCES OF HARDWOOD DECLINE

- Associated with the acid rain question is the rapid reduction in growth rate of sugar maple trees since about 1960. Reduced growth rates are more evident in areas subjected to atmospheric contaminants. In southwestern Ontario, acid rain and ozone are co-deposited and it is difficult to asses their relative contributions to the reduced growth rate.

  With reduced rates of growth, less timber will be produced for future harvests. Salvage cutting of affected trees in areas where dieback is encountered is a short term solution and disrupts timber harvest plans.

- Quebec produces about 70 percent of the world's maple syrup and some 15,000 producers in North America rely on the sugarbush for at least part of their income.

- Although it is difficult to assess, loss of forest cover could have a major impact on non-timber forest resource utilization such as hunting and tourism.

RISKS FOR AGRICULTURAL PRODUCTION

Results of experimental studies indicate that repeated occurrences of highly acidic rain or fog with a pH of less than 3.0 will increase the likelihood of foliar damage to agricultural crops. (Rain in the absence of pollution is expected to have a pH of 5.6, resulting from dissolved carbon dioxide which is naturally present in the atmosphere.) Direct damage has not been certified under natural conditions as the pH of typical rainfall is about 4.2 in southern Ontario.

Acidic deposition could result in soil pH depression. This would increase the frequency of application of agricultural limestone to the crop land. It would be very difficult to attribute any increased demand for lime application when normal agricultural practices, including application of nitrogen-based fertilizers, will also result in soil acidification.

RISKS FOR WILDLIFE

- Large scale losses of the tree canopy are predicted to lead to a decreased abundance of birds that rely on the canopy for food and shelter.
- Conversely, some bird species that feed among shrub layers on the ground may have increased habitat.
- Following soil acidification, metals and other contaminants, especially cadmium, become more available for uptake through roots of the plants on which animals feed. As a result, these metals can be accumulated in the tissues of wildlife in remote areas which are sensitive to acidification.
- Metals are known to accumulate in lichens which are a food source for wildlife. Moose and deer have accumulated such high concentrations of cadmium in their livers and kidneys that these organs have been declared unit for human consumption in several provinces in Canada.

FOR MORE INFORMATION

Ministry of Environment and Energy has several information pieces about acid rain and other topics. These are available through the ministry's Public Information Centre, located at 135 St. Clair Ave. W., Toronto, Ontario M4V 1P5. The Public Information Centre is open Monday through Friday, from 9:00 a.m. to 4:30 p.m.

Or call:

Outside of Toronto **1-800-565-4923**
in Toronto **323-4321**

REFERENCES

George H. Tomlinson "Effects of Acid Deposition on the Forests of Europe and North America" 1990.

The 1990 Canadian Long-Range Transport of Air Pollutants and Acid Deposition Assessment Report, Part 5, Terrestrial Effects. 1990

Acid Precipitation in Ontario Study (APIOS) Annual Program Report. 1989/1990